

What is claimed is:

- 1           1.     A system for audio reproduction comprising:  
2                 means for obtaining one or more audio signals that are representative  
3                 of sounds occurring at a first location;  
4                 means for communicating the audio signals from the first location to a  
5                 second location of a person;  
6                 means for determining a position of the head of the person in at least  
7                 two dimensions at the second location by imaging the person; and  
8                 plural means for reproducing an audio field at the second location from  
9                 the audio signals, wherein sounds emitted by each means for reproducing are  
10                controlled based on the position of the head of the person.
- 1           2.     The system according to claim 1, wherein the audio field is reproduced  
2                 in real time.
- 1           3.     The system according to claim 1, wherein said means for determining  
2                 repeatedly determines the position of the person and wherein said means for  
3                 reproducing is continuously controlled in response to changes in the position  
4                 of the head of the person.
- 1           4.     The system according to claim 1, wherein the position of the head of  
2                 the person is determined in horizontal directions and wherein volume for  
3                 reproduction by each means for reproducing is controlled based on the  
4                 horizontal distance between the head of the person and the means for  
5                 reproducing.
- 1           5.     The system according to claim 4, wherein each of the plural means for  
2                 reproducing comprises a speaker.
- 1           6.     The system according to claim 4, wherein each of the plural means for  
2                 reproducing comprises at least a pair of vertically arranged speakers.

1           7.       The system according to claim 1, wherein the position of the person is  
2           determined in three dimensions, including horizontal and vertical directions.

1           8.       The system according to claim 7, wherein each of the plural means for  
2           reproducing comprises at least a pair of vertically arranged speakers.

1           9.       The system according to claim 8, wherein the volume of reproduction  
2           by each of a pair of vertically arranged speakers is based on the position of the  
3           head of the person in the vertical direction.

1           10.      The system according to claim 9, wherein when the head of the person  
2           is positioned below a vertical threshold, substantially all of the sound  
3           reproduced by the pair of the speakers is reproduced by a vertically lower one  
4           of the pair and wherein when the head of the person is positioned above the  
5           vertical threshold, substantially all of the sound reproduced by the pair of  
6           speakers is reproduced by a vertically higher one of the pair.

1           11.      The system according to claim 10, wherein the threshold is hysteretic.

1           12.      The system according to claim 10, wherein when the head of the  
2           person transitions across the threshold, transitioning of the sounds from one  
3           speaker of the pair to the other is gradual.

1           13.      The system according to claim 1, wherein the plural means for  
2           reproducing are arranged spaced apart and directed toward a center and  
3           wherein a particular one of the audio signals applied to a particular one of the  
4           means for reproducing is multiplied by a ratio of a horizontal distance between  
5           the particular means for reproducing and the head of the person to a horizontal  
6           distance between the particular means for reproducing and the center.

1           14.      The system according to claim 1, wherein the particular one of the  
2           audio signals is multiplied by a factor related to the position to determine a  
3           desired signal level for the particular one of the audio signals and when the

4 desired signal level is substantially different from a current signal level  
5 gradually adjusting the current signal level toward the desired signal level.

1 15. The system according to claim 14, wherein the sounds are digitally  
2 sampled at a sampling rate and the current signal level is incrementally  
3 adjusted in uniform increments, one adjustment for each of a predetermined  
4 number of samples.

1 16. The system according to claim 15, wherein the increment is related to a  
2 difference between the desired signal level and the current signal level.

1 17. The system according to claim 1, wherein the plural means for  
2 reproducing are arranged spaced apart and directed toward a center and  
3 wherein a particular one of the audio signals applied to a particular one of the  
4 means for reproducing is time delayed based on the position of the person.

1 18. The system according to claim 17, wherein the particular one of the  
2 audio signals is time delayed by:  
3 computing a desired delay by determining a distance between the head  
4 of the person and the particular one of the means for reproducing, subtracting  
5 the difference by a maximum distance between the head of the person of the  
6 particular one of means for reproducing to determine a result and dividing the  
7 result by the speed of sound; and  
8 when the desired delay is substantially different from a current delay,  
9 gradually adjusting the current delay toward the desired delay.

1 19. The system according to claim 18, wherein the sounds are digitally  
2 sampled at a sampling rate and the current delay is gradually adjusted by  
3 approximately between three and ten percent of the sampling rate.

1 20. The system according to claim 1, further comprising means for  
2 displaying visual images to the user including a source of the sounds.

1 21. A method for audio reproduction comprising:

2 obtaining one or more audio signals that are representative of sounds  
3 occurring at a first location;

4 communicating the audio signals from the first location to a second  
5 location of a person;

6 determining a position of the head of the person in at least two  
7 dimensions at the second location by imaging the person; and

8 reproducing an audio field at the second location from the audio  
9 signals, wherein sounds emitted by each of plural means for reproducing are  
10 controlled based on the position of the head of the person.

1 22. The method according to claim 21, wherein volume of reproduction is  
2 controlled based on the position of the head of the person

1 23. The method according to claim 21, wherein delay associated with  
2 volume of reproduction by each means for reproducing is controlled based on  
3 the position of the head of the person.

1 24. The method according to claim 21, wherein the audio field is  
2 controlled based on the position of the person's head in three dimensions.

1 25. A telepresence system comprising:  
2 a display booth having a plurality of cameras for obtaining images of a  
3 person within the display booth;  
4 a computer system for determining a position of the head of the person  
5 in at least two dimensions from the images of the person; and  
6 a plurality of speakers for reproducing an audio field at the display  
7 booth, wherein the audio field is controlled based on the position of the head  
8 of the person.

1 26. The telepresence system according to claim 25, wherein volume of  
2 reproduction by each speaker is controlled based on the position of the head of  
3 the person.

1        27.     The telepresence system according to claim 25, wherein delay  
2        associated with volume of reproduction by each speaker is controlled based on  
3        the position of the head of the person.

1        28.     The telepresence system according to claim 25, wherein the audio field  
2        is controlled based on the position of the person's head in three dimensions.